MOTOROLA

OSCILLOSCOPE

T-1014 B

MP MASTER
MA36321

MOTOROLA OSCILLOSCOPE

TYPE 1014B

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THE OSCILLOSCOPE TYPE T1014B (S32A)

T.1014B is a precision oscilloscope built specially for Motorola. Design is based on the Telequipment S32A, which is referred to throughout this Manual. The main difference between Motorola T.1014B and the Telequipment S32A is in the provision of a variable gain facility in the Vertical Amplifier. Provision is made to vary the gain over a range of approximately 3 : 1.

The circuit arrangement providing variable vertical gain consists of 1 K inverse log potentiometer which varies the coupling between the cathodes of V1 and V2. As adjustments of this control would cause variations in the DC level of the amplifier, should any unbalance exist in this stage, a DC balance control is provided at the grid of V2.
(See diagram on page 31).

FIRST TIME OPERATION

In addition to the setting up instructions on Page 5, the variable controls should be set as follows:-

Volts/cm.	VARIABLE	Fully clockwise

VOLTAGE CALIBRATION

When calibrating or making voltage measurements, V/cm variable should always be at maximum (fully clockwise).

REPAIRS AND REPLACEMENT PARTS

The unusual accessibility of components and the maintenance notes and diagrams in this book make servicing and adjustment of the instrument quite simple. However, if it should ever be necessary to return it for repair, please attach to the instrument a note of the fault, pack it carefully and ship prepaid to the Data Instruments Division, Industrial Electronic Hardware Corporation, 7300, Crescent Boulevard, Pennsauken, New Jersey,U.S.A.

Exact replacements of all parts can be ordered from the above address.

GENERAL DESCRIPTION

CATHODE RAY TUBE

The 3" flat faced tube operates at 3.4 Kv overall, giving an extremely bright fine trace over the whole of the working area (5cms x 5 cms). A P1 phosphor is normally supplied but a long persistence tube is available if specified.

A green filter improves the contrast under conditions of high ambient light.

VERTICAL DEFLECTION AMPLIFIER

The four-stage, balanced, D.C. coupled amplifier drives the deflector plates through output cathode-followers. The amplifier is compensated for optimum pulse response with no overshoot. The amplifier has a sensitivity of 100mV per centimetre DC to 10 Mc/s (-3dB) with the Y amplifier gain switch in the normal position and a sensitivity of 10 mV per centimetre DC to 1.0 Mc/s (-3dB) with the Y amplifier gain switch in the X 10 position.

The nine-position input attenuator is frequency compensated and gives sensitivities of 100 mV (10mv), 200 mV (20mv), 500mV (50mv), 1V (100mV), 2V (200mV), 5V (500mV), 10V (1V), 20V (2V), 50V (5V). The bracketed figures apply with the amplifier gain switch in the X 10 position.

The preset gain controls located on the underside of the S32A standardise the sensitivities of the amplifiers against an internally generated 1V p.p. squarewave.

The input impedance is 1 megohm, shunted by about 30pf.

VOLTAGE CALIBRATOR

A 1 volt p.p. squarewave, stabilised against line voltage variations is available at a connector on the front panel.

SWEEP CIRCUIT

The sweep generator is a Miller run-down circuit giving excellent linearity. Eighteen pre-set sweep speeds are provided from 1 usec/cm to .5 sec/cm. Slower speeds down to about 2 seconds, can be obtained by adjusting the SET SPEED control to the bottom end of its range.

An uncalibrated control is provided, allowing continuously variable change of sweep speed on each pre-set switch position.

HORIZONTAL AMPLIFIER

The X GAIN control expands the trace to over 10 diameters and sufficient shift is provided to enable any part of the expanded trace to be positioned centrally on the screen.

TRACE UNBLANKING

D.C. coupling of the unblanking waveform gives uniform trace brightness at all sweep speeds and operates in such a way that the time base flyback is completely eliminated.

TRIGGERING

Three modes of triggering are provided:

1. AUTO. On this setting the sweep free runs at a slow speed in the absence of an input signal, but will be triggered automatically as soon as a signal is applied. This mode of operation can be used for 90% of normal laboratory uses.

2. TRIGGER LEVEL SELECTION. Withe the AUTO switch OFF the Trigger Level Control allows the sweep to be triggered at any point on the input waveform.

3. H.F. In this position, the sweep free runs at approximately 500 Kc/s and is synchronised by incoming signals up to at least 10 Mc/s.

The built-in TV sync separator triggers the sweep from the Line or Frame pulses of a composite Television waveform.

REAL CONNECTORS

Connectors on the rear panel provide access to the Horizontal Amplifier, intensity modulation of the beam and the sweep output waveform.

REMOVAL OF COVERS

Access to all tubes and preset adjustments can be gained by removing the two side covers. Slacken off the two screws on the top which hold the carrying handle and push the right-hand cover to the right and the left-hand cover to the left. They will both then lift out. If it ever becomes necessary to remove the bottom :

Remove the screws fixing the rear panel and take it off.

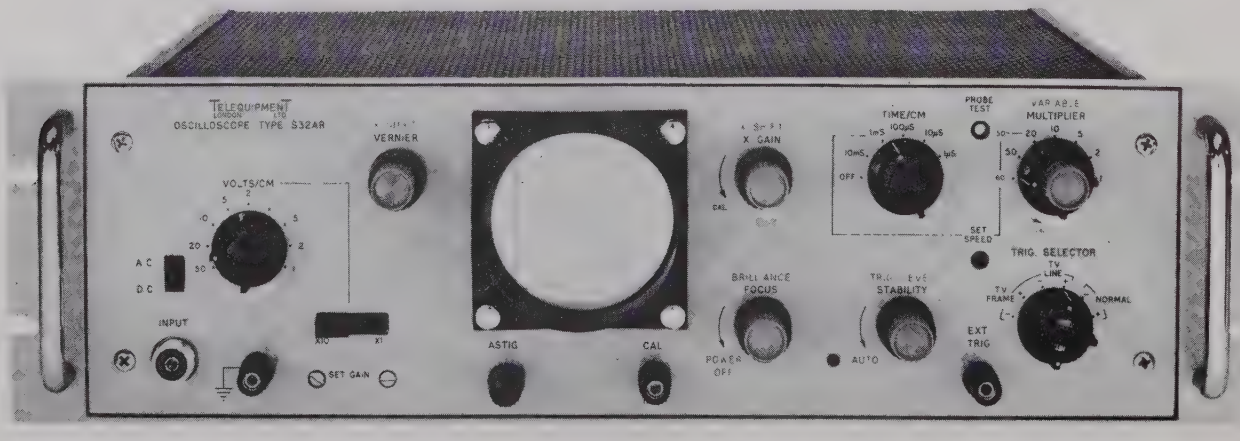
Turn the scope upside down and slide chrome trim rearwards.

Lift the bottom and pull gently rearwards, lifting it clear.

Remove the labels "Set gain Y1", "Set gain Y2", etc.

The S32A is cooled by convection. Air enters the bottom of the case and is drawn up past the tubes and other hot components. Do not obstruct the air flow in any way. Do not put anything on top of the instrument and make sure that there is an air space underneath.

X GAIN
STABILITY
TIME/CM
100µS
10µS
1mS
OFF
PROBE TEST
FOCUS
VERNIER
TV SYNC SEPARATOR
LINE
FRAME
NORMAL
VOLTS/CM
EXT TRIG
CAL
TELEQUIPMENT


TELEQUIPMENT
LONDON
OSCILLOSCOPE TYPE S32AR
VERNIER
VOLTS/CM
A C
D C
INPUT
X10
X1
SET GAIN
ASTIG
CAL
X GAIN
CAL
TIME/CM
1mS
100µS
10µS
10mS
µS
OFF
PROBE TEST
VARIABLE MULTIPLIER
SET SPEED
TRIG. SELECTOR
TV LINE
TV FRAME
NORMAL
BRILLIANCE FOCUS
POWER OFF
STABILITY
AUTO
EXT TRIG

FIRST TIME OPERATION

Unless you are familiar with this type of sweep generator, follow these simple instructions carefully and then run through the procedure a few times to feel thoroughly at home with the instrument before putting it into use.

Set the front panel controls as follows:

INPUT SWITCH	D.C.
VOLTS/CM	.5
Y AMPLIFIER GAIN	X1
FOCUS	Mid position
ASTIG	Mid position
Y SHIFT	Mid position
BRILLIANCE	Fully anti-clockwise
X GAIN	Fully anti-clockwise
X SHIFT	Mid position
STABILITY	Fully clockwise
TRIGGER LEVEL	Anti-clockwise to position just before switch operates
TIME/CM	1 ms
MULTIPLIER	20
VARIABLE	CAL
TRIG. SELECTOR	Normal. +ve Int.
NORMAL/HF SWITCH	Normal

Switch on and allow a few minutes for the instrument to warm up. Now advance the brilliance control until a trace appears and position the trace in the centre of the screen by means of the X and Y SHIFT controls. Adjust the ASTIG and FOCUS controls for a clean sharp trace.

Now back off the STABILITY control until the sweep just fails to free run. This is the normal position of the STABILITY control and once it is set it should not require any re-adjustment except at the very highest sweep speeds. The instrument is now ready for use.

You will find that if the TRIGGER LEVEL control is turned fully anti-clockwise to operate the AUTO switch, the trace will reappear. In this condition the instrument is ready to accept almost any input waveform and trigger automatically from it, the only adjustments required are the selection of the appropriate sweep speed and Y Sensitivity (VOLTS/CM). However, in order to use the S32A to best advantage the functions of the controls should be understood fully and the following procedure will demonstrate their use.

Return the TRIG. LEVEL control to the position just before the Switch operates. There should now be no trace visible on the screen.

Now join a short connector between the CAL. post and the INPUT sockets and rotate the TRIG. LEVEL control clockwise until the trace appears. (If the sweep does not trigger it is because the STABILITY control has been backed off too far.) The Scope is now displaying the calibration voltage waveform which should be a squarewave of 2 cm amplitude with one cycle occurring every cm. You will find that this is a very convenient waveform for demonstrating the functions of the controls.

FOCUS AND ASTIG

You will find that by adjusting the FOCUS control either the horizontal or vertical edges of the squarewave can be brought into focus, but only if the ASTIG. control is in the correct position will it be possible to focus the whole of the waveform simultaneously. Once the ASTIG. control is set it should require no further adjustment and a clean fine trace will be obtained over the whole of the screen.

SWEEP CONTROLS

TIME/CM., MULTIPLIER & VARIABLE

The calibration waveform is at supply line frequency so that when operating on 50 c/s, 1 cycle occupies 20 milliseconds. With the TIME/CM switch set to 1 millisecond, the MULTIPLIER to 20, and the VARIABLE set to CAL., the TIME BASE speed is 20 milliseconds per cm. so that 1 cycle should occupy 1 cm. The SET SPEED control beneath the instrument is used to adjust the sweep speed on this calibration waveform to give precisely 1 cycle per cm. When using the S32A on a 60 cycle supply, set the MULTIPLIER to the CAL. 60 c/s position. This standardises the whole of the time calibration of the instrument, all other ranges being direct multiples of this. Thus, if the MULTIPLIER is set to 10 (10 ms/cm.) 1 cycle will occupy 2 cm. and similarly at 5 ms./cm. 1 cycle will occupy 4 cm. and so on. In every case the time calibration is obtained by multiplying the TIME/CM by the MULTIPLIER setting.

You will see that the ranges overlap. For instance 20 ms. can be obtained by 1 ms./cm. multiplied by 20 or 10 ms./cm. multiplied by 2. In general use the 10, 20 and 50 steps on the slow speeds and the 1, 2 and 5 steps on the high speeds. The uncalibrated VARIABLE CONTROL gives a range of approx. 10:1, so covering the TIME/CM ranges.

For most purposes, however, when time calibration is not required, use these controls to produce a picture of convenient size, the TIME/CM, the coarse control and the VARIABLE as the fine control.

If the instrument is calibrated as above the slowest sweep speed obtainable will be 500 ms/cm. For special purposes you may require to use speeds slower than this and the range of the pre-set control has been extended in the lower direction to allow for this. You will find that

with this control turned to its minimum position the slowest speed range is extended to about 2 seconds per cm. If the instrument is standardised against the internal calibration waveform on the 5 ms./cm. range and the pre-set control is adjusted to give 1 cycle per cm., all the time ranges are multiplied by a factor of four. On the 60 c/s supplies set the TIME/CM. switch to 100 usecs. and the MULTIPLIER to the CAL.60 c/s position and adjust the pre-set control to give 1 cycle $\frac{1}{2}$cm. long, this gives a multiplying factor of(5).

TRIG LEVEL

Set the MULTIPLIER as explained above to 5ms/cm. giving 1 cycle of the squarewave 4 cm. long. Now rotate the TRIG.LEVEL control and it will be found that the starting point of the trace can be moved up and down the sloping edge of the squarewave. If the control is turned too far clockwise the trigger point goes over the top of the squarewave and the sweep stops. Similarly, rotation too far anticlockwise sets the point too low and the sweep again stops. It should now be appreciated that this control does not govern the amplitude of the trigger signal but sets the precise point or level at which the sweep triggers. Thus, by adjusting this control, the sweep can be made to trigger at any point on the input waveform. (Positive or negative edges can be selected on the TRIG. SELECTOR SWITCH.) This facility is extremely useful when dealing with complex waveforms when a normal type of sweep generator will either not trigger at all or will double trigger and produce a multiple pattern. It is also useful as an amplitude discriminator enabling the sweep to ignore small amplitude signals and only trigger when the input voltage reaches a predetermined value. You will find that adjusting the sweep speed control does not alter the trigger point, the trace simply expands from the given starting point. This will enable you to examine a section of the waveform in detail by setting the TRIG. LEVEL control to trigger just before the portion to be examined and expanding this portion as required by the sweep speed control.

AUTO

On this setting no control over the trigger level is available. The sweep automatically adjusts itself to trigger at approximately the mean level of the input waveform. You can use this setting for practically all applications involving repetitive waveforms of a fairly simple nature and the sweep generator will trigger automatically on signals between about 50 c/s and 1 Mc/s. provided the amplitude exceeds about 2 mm.

In the AUTO position with no input signal the trace will become progressively less bright as the sweep speed is increased. This is normal since in the absence of a trigger signal the sweep free runs at about 50 c/s whatever the setting of the speed control. As soon as an input signal is applied the sweep will immediately synchronise to it and the trace will revert to its full brightness.

TRIG. SELECTOR

There are twelve positions on this selector switch. For most purposes use the positive or negative normal positions depending on the polarity of the input waveform.

The other four positions bring the internal Sync. Separator into circuit for use on TV waveforms enabling the sweep to be triggered from the Line or Frame pulses independent of the picture content (the +ve TV positions refer to positive-going video signals, i.e. picture + ve sync. - ve). When triggering from a TV frame pulse, adjustment of the TRIG. LEVEL control will determine which of the broad pulses actually triggers the sweep.

The Sync. Separator includes an integrating circuit for the frame pulse and this can be useful on occasions for frequency discrimination. For instance an audio signal containing a large proportion of HF noise will trigger better

on the TV frame position, the integrator acting as a low pass filter.

For triggering from an external signal rotate the control knob until the ext. position is uppermost and connect the signal into the external trigger socket.

X-GAIN and X-SHIFT

With the X-GAIN control in the minimum (anti-clockwise) position, the trace will be approximately 6 cm. long and the X-SHIFT control should be used to centre this trace about the 5 x 5 cm. ruled graticule. Increasing the X-GAIN control expands the trace about the centre of the screen up to a maximum of just over 10 screen diameters giving an effective trace length of 60 cm. and the X-SHIFT control is then used to position the required portion of this trace on the screen.

It should be noted that the time calibration only holds good at the minimum setting of the X-GAIN control. If you want to measure time intervals at any other setting the speed must be standardised at this setting by means of the internal calibration waveform. For instance, if the X-GAIN control is increased so that 1 cycle of the calibration waveform occupies 5 cm. then the gain is exactly five times on all ranges and provided the X-GAIN control is not touched all sweep speeds will be multiplied by a factor of 5. Obviously you can have any multiplication factor between 1 and 10.

VOLTS PER CM.

This is a nine-position switch which inserts a series of frequency compensated resistance dividers between the input socket and the Vertical Amplifier. Normally this is used merely to obtain a picture of convenient height, but if the gain of the Amplifier is standardised, direct readings of input

voltage can be made. For this purpose the gain should be set by means of the SET Y-GAIN pre-set controls on the front panel so that the 1 volt squarewave calibration occupies exactly 2 cm. on the .5v/cm. scale with the Y-GAIN control in the normal position. With the gain in X 10 position the 1 volt squarewave will occupy 2 cms. on the 5 v/cm. scale. The squarewave amplitude should be measured between the horizontal flat portions. All other ranges are then direct readings in volts per cm.

X1. X10 GAIN SWITCH

This switch changes the value of plate loads of V1, V2, V3 and V4, and adds feedback between V3A and V4A cathodes, the sensitivity being multiplied by 10 when the X10 position is selected, the attenuator reading in volts/cm should be divided by 10, and in the X1 position will be read directly.

D.C./A.C. SWITCH

On the A.C. position this switch inserts a blocking capacitor in series with the input of the Vertical Amplifier removing the D.C. component of the signal. This is the condition in which the S32 will normally be used unless it is specifically required to include the D.C. component or to use the instrument on very low frequency signals. The time constant of the input circuit on the A.C. position is such that the response is 3 dB down at 2 cycles, which, while adequate for all normal purposes, may limit the application in some instances. For example, you will notice that on the 50 cycle squarewave a pronounced tilt occurs on the A.C. position. If a longer time constant is required, a higher capacity external blocking capacitor must be used with the input switch set to D.C.

REAR CONNECTORS

1. Sweep output. A negative going saw-tooth waveform of approximately 35 volts amplitude is available at this connector and can be used for instance, to drive an external circuit. This socket is D.C. coupled to preserve the shape of the waveform at the lowest sweep speeds and in some instances a blocking condenser may have to be used. The output waveform is only linear when the X-GAIN control is set to the minimum position. At all other settings of the X-GAIN control only the portion of the saw-tooth which is actually on the screen is linear. When using this waveform as a drive for an external circuit, it will usually be necessary to turn the STABILITY control clockwise until the sweep free-runs.

2. X-Amp Input. This socket provides an access to the input of the Horizontal Deflection Amplifier and is suitable for signals between about 1 and 25 volts p.p. The X-GAIN control gives about a 10 to 1 variation of gain. When using the X-Amplifier the sweep can be stopped by turning the STABILITY control fully anti-clockwise. The input impedance is about 500 K and the input capacity about 100 pf. The frequency response is 3 dB down at 5 cycles and at about 400 Kc/s.

3. Z. Mod. This socket is connected via a blocking capacitor to the cathode of the C.R.T. Thus, a negative pulse will brighten the trace. The time constant of this circuit is .01 mf. and 10,000 ohms.

SIMPLIFIED METHOD

In the above instructions the functions of controls have been explained in some detail so that the engineer using the S32A may fully appreciate its capacities and the method of function. There will, however, be a large number of users who will not require all the facilities provided and to whom

simplicity of operation is of major importance. The following simplified instructions will suffice for most applications, in fact for any application where the older type of Oscilloscope could be used the following method will provide better results much more quickly and simply.

Set input switch to A.C.

Switch on and allow a few minutes to warm up.

Turn STABILITY control fully clockwise and adjust BRILLIANCE and FOCUS controls for a sharp trace.

Back off STABILITY control until the TIME BASE stops. The STABILITY control once set should not require any further adjustment.

The instrument is now set for use.

For most applications switch to AUTO, connect input signal, switch amplifier Gain Control to normal and adjust VOLTS/CM switch to give a convenient size trace. Use TIME/CM and MULTIPLIER as coarse and fine frequency controls to suit the input signal. Leave VARIABLE CONTROL in the CAL. position.

For T.V. waveforms use line or frame positions of TRIG. SELECTOR. If the sweep fails to lock, the STABILITY control has been turned up too far.

For some input waveforms and sometimes for TV waveforms it may be necessary to adjust the TRIG. LEVEL control rather than to use the AUTO position.

CIRCUIT DESCRIPTION

INPUT ATTENUATOR

The input capacitor C.1. is normally in series with the input to the Attenuator but is shorted by S.1 in the D.C. position. The input Attenuator has four frequency compensated resistance dividers and these are used singly or in cascade giving nine division ratios. The first section has ratios of 1, 10 and 100, and the second section 1, 2 and 5.

VERTICAL AMPLIFIER

The Vertical Amplifier uses two pentode valves (type EF 184) and three double triodes (type ECC 88). The input signal is fed from the attenuator network to the grid of V1. The input stage consists of a cathode-coupled pair (V1 and V2). An out of phase signal appears at the anode of V1 and an in phase signal at the anode of V2. These anodes are direct-coupled to the cathode followers V10A and V10B respectively. The inductors (L1 and L2) in the anode circuits of V1 and V2 are peaked for optimum response. R32, connected between the cathodes of V1 and V2, is the X1 preset gain control. The potentiometer (R18) controls the relative DC anode potentials and this affects the balance of the output valves and consequently acts as a Vertical Shift (Y SHIFT COARSE) control. When the amplifier is operated at high gain (in the "X10" condition) R21 acts as a "Fine" Y SHIFT control or vernier. The cathodes of V10A and V10B are directly connected to the grids of the output amplifier valves, V4A and V5A. The cathodes of these valves are connected, via the "SET GAIN" control R33 (SET GAIN X10). The switch (Y GAIN - X1/X10) short circuits R33 in the X1 position and in the "X10" position R33 controls the gain. The inductors (L3 and L4) in the anode circuits of V4A and V5A provide compensation at high frequency on the "X1" range (DC - 10 Mc/s). In the "X10" condition the cathode bias resistors of V4A and

V5A (R38 and R41) are not returned to earth, but to the preset "ASTIG BAL" variable resistor (R43). This control is used to correct the DC level of the cathodes of V4A and V5A when the valves are operating at high gain. Incorrect adjustment affects the potential of the Y plates of the CRT, causing astigmatism of the spot. The vertical deflection outputs to the CRT "Y" plates are fed from the cathode followers V4B and V5B. The signal from the cathode of V4B is also taken to the Y1, Y2 positions of the Trigger-Selector switch (S101, Fig. 2.1). The neon diodes (N1 and N2) between the grids and cathodes of V4B and V5B protect these valves from the voltages which appear at their grids immediately upon switching on, before the cathodes reach full emitting temperature.

When the Y GAIN switch is in the "X10" position, higher value load resistors are switched into the anode circuits of the input and output amplifier valves (V1 and V2, V4A and V5a). The maximum sensitivity of the amplifier is then 10 mV/cm. and the gain can be adjusted, for calibration purposes, by the SET GAIN X10 control (R33). The anode and screen voltages for V1 and V2 are taken from a common resistor (R46) in the cathode circuits of V4B and V5B. The cathode current of the input stages therefore flows through the two output cathode followers. This reduces the total current consumption of the amplifier, and provides a measure of stabilization, so that the overall gain is proportional to the power supply voltage. A negative supply is obtained by rectifying the 12.6v heater winding. This voltage is smoothed by C63, R146 and C62. The negative voltage allows the cathode resistors, R16, R145, to be large, so ensuring a constant current through the valves.

TRIGGER CIRCUIT AND SYNC. SEPARATOR

The TRIG. Selector Switch S4 has three sections. The first selects either internal or external triggering. The second, the positive or negative output of the phase splitter V5b and the third section either the output of the phase splitter direct or the output of the T.V. Sync. Separator

V5a. V5b is a conventional phase splitter, an in-phase signal appearing at its cathode and an out of phase signal at its plate. The T.V. Sync. Separator V5a accepts a negative going input waveform, i.e. Sync. pulses positive, and provides negative going Sync. pulses at its plate. The integrating circuit R60, C23 effectively removes the line pulses leaving only the frame pulses.

From the phase splitter or from the Sync. Separator the Triggering signal is injected into the grid of V6a. V6a and V6b form a conventional cathode coupled bistable switch, the switching level being adjusted by the potential at the grid of V6a. The grid resistor of V6b and R71 is adjusted to give maximum sensitivity consistent with reliable triggering. On the AUTO position the switch S5 is opened and the grid of V6a is returned to the grid of V6b. In the absence of a signal V6 oscillates at a frequency determined by the time constant of R66 and C24 but as soon as any input signal between about 50 cycles and 2 Mc/s is applied to the grid of V6a this self oscillation ceases and the grid of V6a assumes the same potential as the grid of V6b. In the HF position of the NORMAL/HF switch, the cathodes of V6a and V6b are capacity coupled, and the circuit oscillates at a frequency of approximately 500 Kc/s. Any incoming signal, from 500 Kc/s upwards, to about 10 Mc/s will then synchronise the oscillator. The square-wave at the plate of V6b is differentiated and used to trigger the time base.

TIME BASE AND HORIZONTAL AMPLIFIER

V7a is the Miller Sweep Generator, the Speed of run-down being controlled by Ca and Ra. Ra is switched to provide the MULTIPLIER and Ca is switched by the TIME/CM. switch. R74 determines the potential to which the charging resistor Ra is returned and is used to set the Sweep speeds. When the VARIABLE CONTROL is switched into circuit, the charging resistor Ra is returned to a variable charging potential, determined by R140. The Miller tube is keyed by V8b which together with V9b form a D.C. coupled multivibrator. In the rest position V8b is conducting and V9b is cut-off its plate being clamped to

250v. by the diode V7b. When a negative trigger pulse is applied to the cathode on V7b it momentarily lowers the grid potential V8b. The resulting rise in plate potential V8b is coupled to the grid of V9b via R97 and Cb, this in turn lowers the plate voltage of V9b still further and the regenerative action V8b going to cut-off and V9b conducting. When the rundown has reached the point where the cathode of V8b is at a lower potential than the plate of V9b, V8b again starts to conduct and a negative pulse is applied to the grid of V9b, regeneration again takes place driving V9b to cut-off and V8b conducting. The STABILITY CONTROL R99 sets the grid potential of V9b to the point just short of the free running condition. The linear sweep voltage at the plate of V7a is taken via the network of R92 C38 and applied to the grid of the Horizontal Amplifier comprising V8a and V9a. R90 and R91 form the grid resistor of V8a, and R103 is made variable to set the trace length at the minimum GAIN position.

The Horizontal SHIFT voltage across R105 is applied in series with the sweep voltage to the grid of V8a. The GAIN of the Horizontal Amplifier is varied by the resistor R110 connecting the cathodes of V8a and V9a. The grid potential of V9a is adjusted by the resistor R115 so that the trace is in the centre of the screen with the Horizontal SHIFT control in its mid position. Outputs from the plates of V8a and V9a are taken to the deflector plates of the cathode ray tube. An external signal can be applied to the grid of V8a via a .22uf capacitor from the connector at the rear of the instrument. In this condition the sweep generator can be stopped by backing off the STABILITY control. The sweep voltage at the cathode of V8a is taken to another connector on the rear of the instrument and can be used to drive an external circuit.

VOLTAGE CALIBRATOR

A square wave of 1V peak to peak is provided for calibrating purposes. This is obtained by applying the 150V tapping on T1 to a zener diode MR5 via C44 and R120. The voltage across MR5 is then attenuated by R116, R117,

R118 and R119 to provide 1V peak to peak square. The temperature coefficient of R119 is selected to match that of the zener diode, so effecting compensation over a wide variation of temperature.

POWER SUPPLY

The Silicon Rectifiers SR1, SR2 in a voltage doubling circuit supply the various B+ voltages via the smoothing resistors R124, R125 and R127. The high voltage supply for the CR tube is derived from the secondary of the power transformer via MR1, this is a tubular metal rectifier of the selenium type. MR1 also provides the negative supply for the sweep generator. The positive High Voltage supply for the post deflection accelerator is also derived from the secondary of the power transformer via the PDA doubler circuit MR2. MR3, the negative terminal of the multiplier being returned to B + 1. Intensity modulation signals can be supplied to the cathode of the CR tube via C58.

ASTIG BALANCE CONTROL

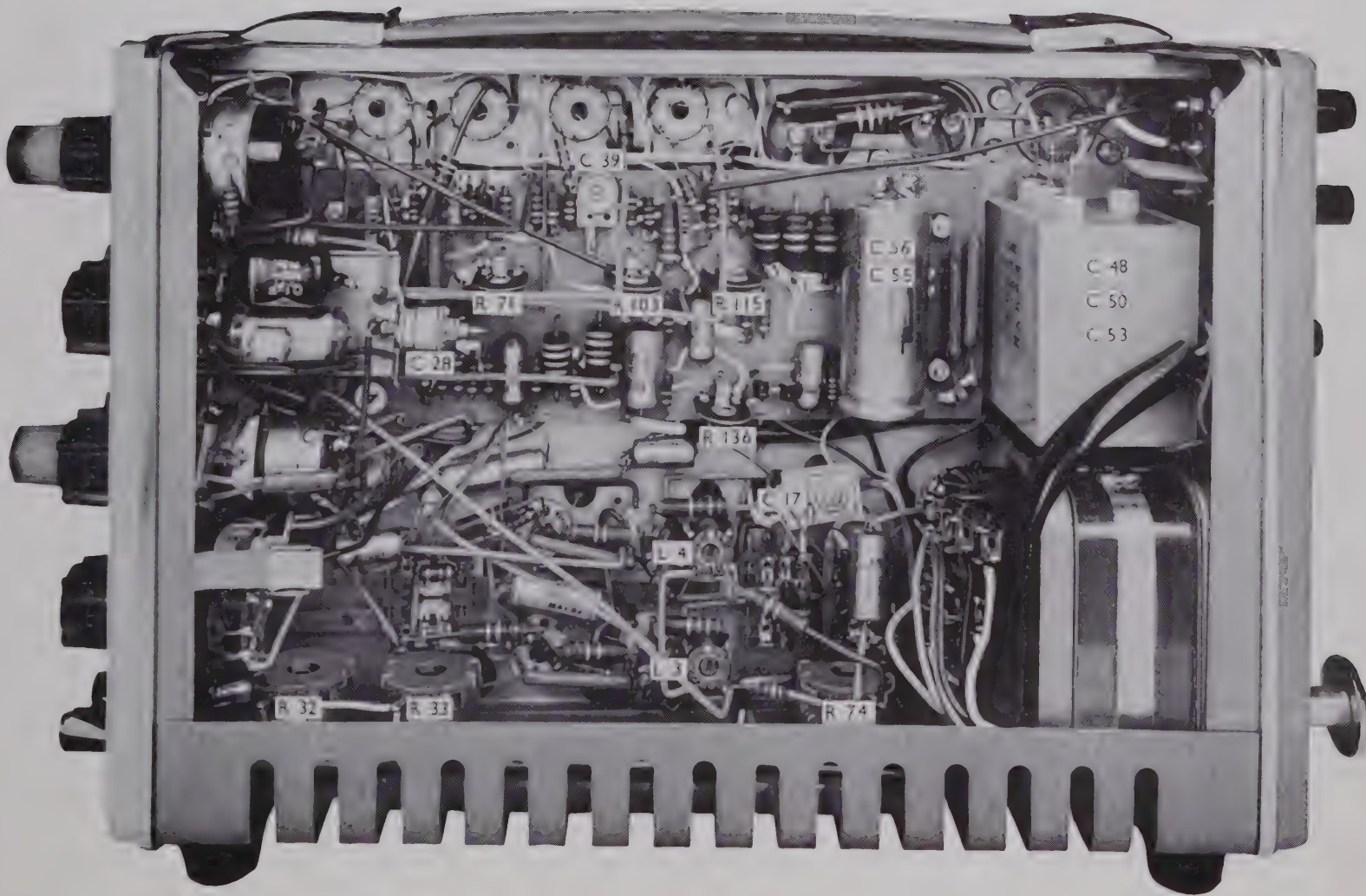
R43 is situated on the underside of the instrument and is provided to ensure that the D.C. voltage present on the Y deflector plates remains constant. This ensures that the Astig control setting remains correct in either position of the Y amplifier gain switch.

COMPENSATION AGAINST LINE VOLTAGE VARIATIONS

No form of stabilisation is used in the power supplies for the S32 but a high degree of compensation for line voltage variations is achieved in the following way:-

The deflection sensitivity of the CR tube is inversely proportional to its final anode voltage and this varies in proportion to the A.C. input voltage. The vertical Amplifier has been arranged so that its GAIN varies in proportion to the B + voltage. It the A.C. input voltage rises, the resulting increase in GAIN of the vertical Amplifier and decrease in sensitivity of the CR tube cancel out. At the

minimum setting of the horizontal GAIN control (that is in the condition in which the sweep is calibrated) the heavy degenerative feed-back in the cathode circuits of the horizontal output tubes V8a and V9a keeps the GAIN of this stage independent of the B + voltage. In the sweep generator itself both the amplitude sweep voltage and the sweep speed in volts per micro-second vary as a direct function of the supply voltage. Obviously, with the inversely varying sensitivity of the CR tube the trace on the screen will remain the same length and have the same speed in CM per micro-secs. In practice this compensation works extremely well and the calibration of the S32 remains constant for widely varying input voltage.


C 39
C 36
C 55
C 48
C 50
C 53
R 71
R 115
C 28
R 130
C 17
L 4
L 3
R 32
R 33
R 74

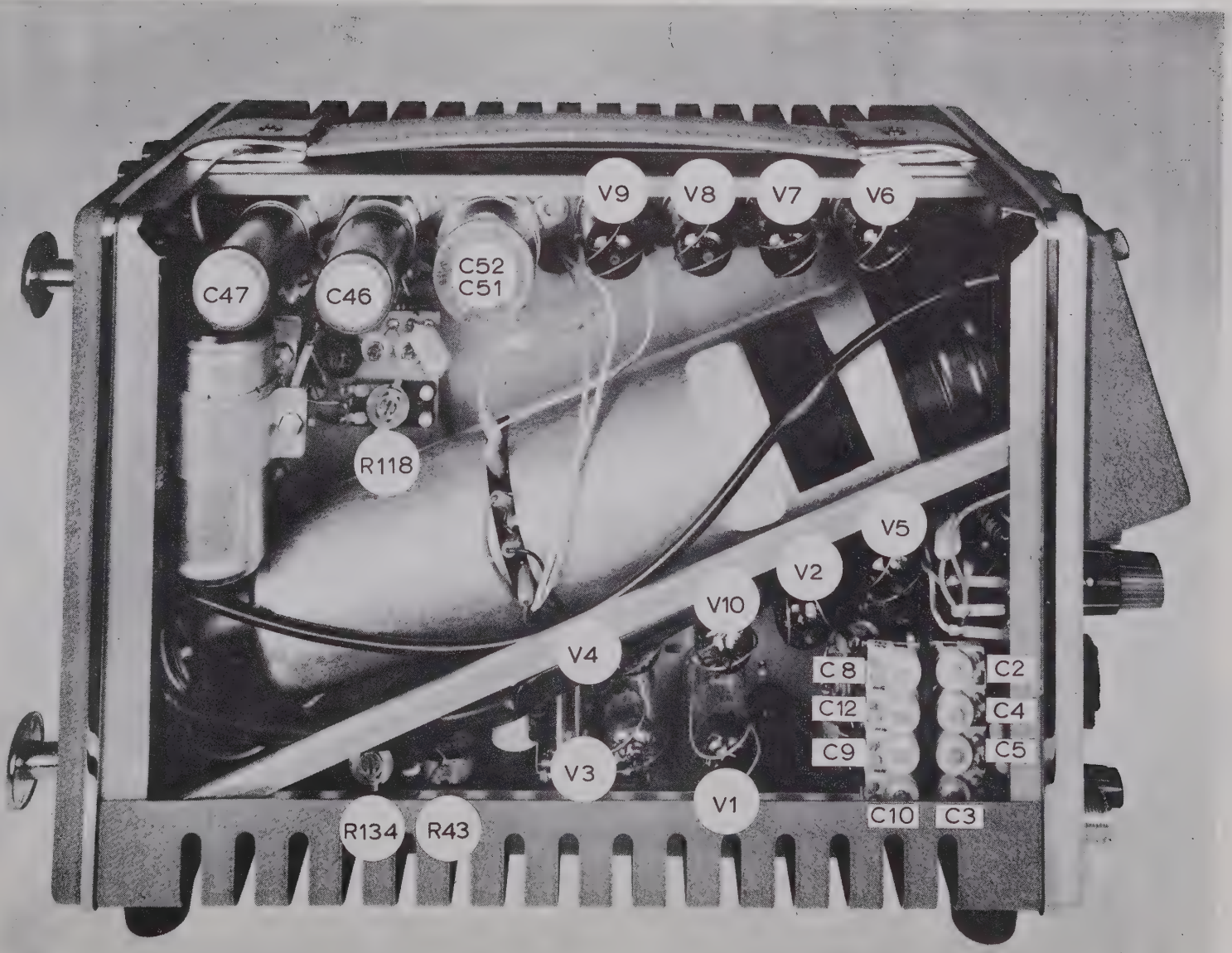
MAINTENANCE ADJUSTMENTS

The simplicity of the circuitry of the S32A makes it an extremely reliable instrument, and for the most part servicing will be limited to the replacement of defective tubes. When replacing tubes in the Vertical Amplifier you may find that you will have to select pairs of tubes of approximately the same characteristics in order to get the vertical SHIFT to operate symmetrically about the centre of the screen; apart from this, replacements of tubes in the Vertical Amplifier will have very little effect on its performance and no re-adjustment should be necessary. In the sweep generator and Horizontal Amplifier the tubes are not particularly critical and you will find that you can replace these without having to alter the internal adjustments. If for any reason the internal pre-set controls do require adjustment the following detailed instructions will allow you to do this quickly and accurately.

ADJUSTMENT PROCEDURE

INPUT ATTENUATOR

In order to adjust the input attenuator compensation you will need a squarewave generator with a frequency of approximately 2 KC's and whose output can be varied between .2 volts and 100 volts. The rise time of the squarewave need not be particularly fast but it must have a good flat top and bottom. Connect the squarewave generator to the input socket and adjust the output to approximately .2 volt. Set the input attenuator to .1 volt per cm. and adjust the sweep controls so that you are displaying 3 cycles of the squarewave. Now carry out the following procedure step by step, adjusting each trimmer to give a square corner to the squarewave. On each setting of the input attenuator you should adjust the output of the squarewave generator to give a trace of approximately 2-3 cm. amplitude.


V9
V8
V7
V6
C47
C46
C52
C51
R118
V5
V2
V10
V4
C8
C12
C9
C2
C4
C5
V3
V1
C10
C3
R134
R43

Set Input Attenuator to:	Adjust
.2 volts per cm.	C12
.5 " " "	C13
1 " " "	C4
2 " " "	C8
5 " " "	C9
10 " " "	C5

If you have carried out these adjustments correctly the 20 volts per cm. and the 50 volts per cm. ranges are automatically correct. In order to adjust the capacitors C2 and C3 it is necessary to use the high impedance probe as these two capacitors only affect compensation when this probe is in use. Remove the squarewave generator from the input socket and plug in the high impedance probe, connect the output of the squarewave generator to the probe tip and set the input attenuator to .1 volt per cm., set the output of the squarewave generator to give approximately 2 cm. amplitude and adjust the probe trimmer (this is accessible through the hole in the probe body) to give a flat top to the squarewave, now switch the input attenuator to the 1 volt per cm. range, re-adjust the output of the squarewave generator and adjust C2, set the input attenuator to the 10 volts per cm. range and adjust C3. All other ranges will automatically be correct.

VERTICAL AMPLIFIER

Adjustment of the high frequency compensation of the vertical Amplifier should only be carried out if you have at your disposal a squarewave generator which is capable of producing an accurate squarewave at a frequency of about 250 KC's with a rise time less than 40 millimicroseconds and which is known to be absolutely free from ring or overshoot. The compensation circuits in the vertical Amplifier are extremely stable and unless such a generator is available you would be wise not to attempt any readjustment. Suitable squarewave generators are the Tektronix and the

Hewlett Packard type 211a, and if one of these or an equivalent is available then the adjustments can be carried out in the following manner:-

Set the input attenuator switch to .1 volt per cm. and adjust the output of the squarewave generator to give a trace of approximately 2 - 3 cm. amplitude (the output frequency on the generator should be between 200 and 300 KC's). The variables L3, L4, C17 and R34 are to some extent interdependent and it may be necessary to adjust any or all of these to obtain the desired result which is a flat topped squarewave with a fast rise time, square corners and no overshoot. L3 and L4 affect the extreme corners of the squarewave and should be adjusted so that they are approximately equal inductances. C17 and R34 have a longer time constant and should be set to give a flat top to the squarewave.

The only other variables on the vertical amplifier are the set GAIN controls, which in the S32A are accessible through the bottom of the instrument.

TRIGGER CIRCUIT

The only adjustment necessary in the TRIGGER circuit is an occasional setting of the TRIGGER sensitivity control R71, this should be set so that the TRIGGER circuit will operate when the trace amplitude on the screen exceeds 1 mm. If any attempt is made to increase the sensitivity beyond this point erratic operation will almost inevitably result. This adjustment can conveniently be made using the internal calibration signal. Join a connector between the CAL. output and the input and adjust the sweep controls so that you are displaying about 5 cycles of the calibration waveform. Now set the input attenuator to the 5 volts per cm. range (giving a trace 2 mm. high) and adjust the TRIGGER sensitivity control so that at a critical setting of the TRIG. LEVEL control the sweep will just trigger; now reduce the trace amplitude to 1 mm. and make sure that the sweep will not trigger on this signal.

SWEEP GENERATOR AND HORIZONTAL AMPLIFIER

To make a complete readjustment of the Sweep Generator and Horizontal Amplifier carry out the following procedure:-

Set the TIME/CM switch to 100 u.secs., the MULTIPLIER switch to 10, and the VARIABLE to CAL. Advance the STABILITY control until the Sweep just free runs. With the X-SHIFT control in its mid position and the X-GAIN control in the minimum position adjust R103 until the trace length is approximately 6 cm. and adjusts R115 to centre this trace about the 5 cm. marks on the graticule. Before commencing the next part of the procedure, remove the lead to the Modulator Anode pin 8 on the CRT. Now advance the BRILLIANCE control until you can see the spot at the beginning of the trace and you will find that by adjusting C39 you will be able to make a small "tail" appear to one side of the spot or the other. The correct setting for C39 is the point at which this "tail" just disappears into the spot, alternatively, C39 can be adjusted by displaying a signal of approximately 100 KC's and setting C31 for optimum linearity at the beginning of the trace, but the first method is more simple and is quite satisfactory. Reconnect the lead to Modulator Anode on C.R.T. Now set the TIME/CM switch to 1 millisecond and the MULTIPLIER switch to 20 (to the CAL. 60 cycle position when the instrument is being operated from a 60 cycle supply). Now display the calibration voltage waveform and set the "set speed" control so that 1 cycle of the calibration waveform occupies exactly 1 CM. (still with the X-GAIN control to its minimum position). Now set the TIME/CM switch to one u.sec. and the MULTIPLIER switch to 1. Inject an accurate 1 megacycle signal into the input and adjust the volts per cm. switch to give a trace approximately 2 cm. amplitude. Now adjust C33 so that each cycle of this 1 megacycle signal occupies 1 cm.

VOLTAGE CALIBRATOR

R118 in the voltage calibrator circuit is provided so that the input can be set to precisely 1 volt. This adjustment can only be made by comparing the output with a known accurate 1 volt peak to peak signal. R118 will normally require no adjustment provided that, if the gas diode N3 is replaced, one of a similar type is used (N1 and N2 have no effect on the amplitude of the output waveform).

CRT CIRCUIT

The Cathode Ray Tube used in S32A is equipped with an inter-deflector plate shield. This is returned to HT1 via a 1 megohm present R135. This is adjusted in order to ensure that the inter plate shield is at the average potential of the deflector plates. Variation of the inter plate shield voltage serves to correct pin cushion and barrel pattern distortion. This control is set during test. No further adjustment should be necessary unless the tube is changed.

HIGH IMPEDANCE PROBE

The adjustment of the probe compensation is best carried out with a squarewave generator with an output frequency of approximately 1 KC. The compensation trimmer is accessible through the hole in the body of the probe and you should adjust this to give a square corner to the squarewave. If a squarewave generator is not readily available the probe can be compensated using an internal signal from the sweep generator in the following manner:-

Set the sweep speed to 1 millisecond per cm. and set the input attenuator to the 20 volts per cm. position. Set the AC/DC switch to AC. Now apply the tip of the probe to the test point and adjust the probe compensating trimmer to give a level start to the trace.

COMPONENT LISTS and CIRCUIT DIAGRAMS

ABBREVIATIONS USED IN COMPONENT LISTS

Capacitors

MP	Moulded Paper
SM	Silver Mica
Cer	Ceramic Tubular
Elec	Electrolytic
P	Paper
POL	Polyester Film
POLY	Polystyrene

Resistors

C	Carbon Composition
HSC	High Stability Carbon
WW	Wire Wound
PS	Pre-set Carbon (Internal Adjustment)

In the following component lists, no manufacturers' names have been included. When replacing components, locally available alternatives may be used if exact replacements are not to hand, provided the physical size is the same.

It is, however, preferable to use exact replacements whenever possible, and these should be ordered direct from:

TELEQUIPMENT LIMITED
313 Chase Road
Southgate,
LONDON, N.14.

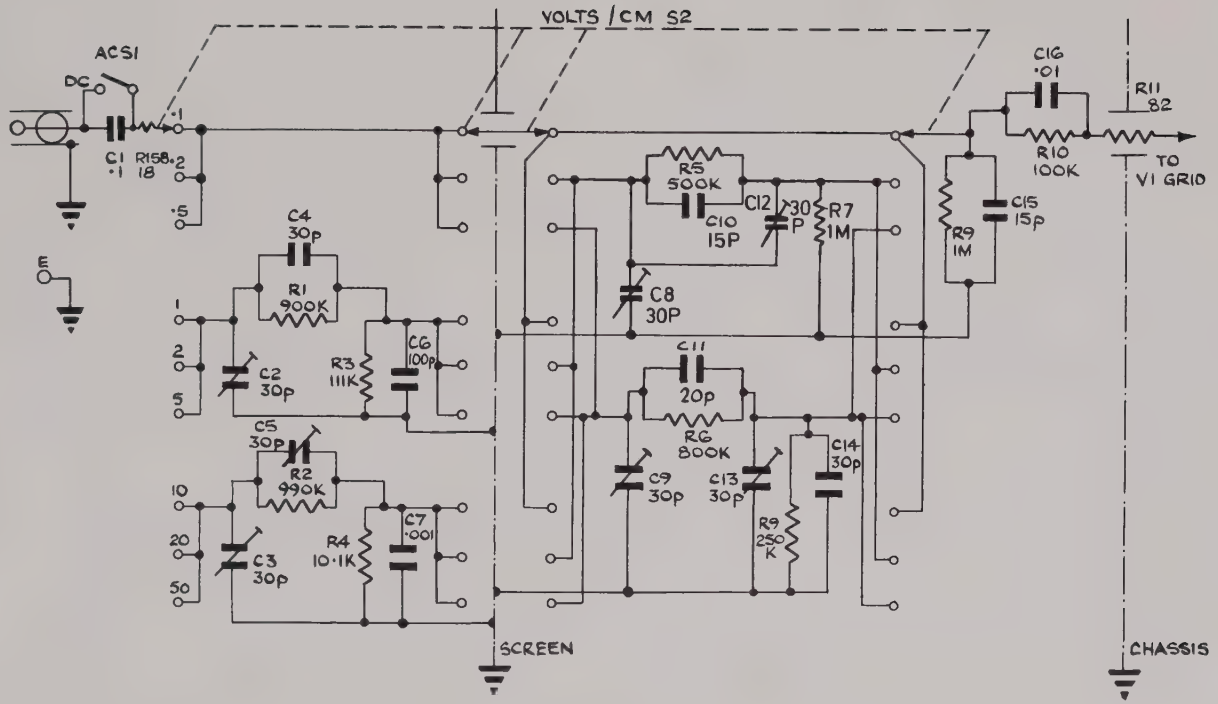
Telephone: FOX Lane 1166
Telegraph: Telequipt. London, N.14.

or from our agents.

INPUT ATTENUATOR

TELEQUIPMENT Part No.	Circuit Ref.	Value	Type	Tol.	Rating
12M	R1	900K	HSC	1%	$\frac{1}{4}$watt
11M	R2	990K	HSC	1%	$\frac{1}{4}$watt
18M	R3	111K	HSC	1%	$\frac{1}{4}$watt
20M	R4	10.1K	HSC	1%	$\frac{1}{4}$watt
14M	R5	500K	HSC	1%	$\frac{1}{4}$watt
13M	R6	800K	HSC	1%	$\frac{1}{4}$watt
10M	R7	1M	HSC	1%	$\frac{1}{4}$watt
17M	R8	250K	HSC	1%	$\frac{1}{4}$watt
10M	R9	1M	HSC	1%	$\frac{1}{4}$watt
S10410	R10	100K	C	10%	$\frac{1}{4}$watt
S82010	R11	82	C	10%	$\frac{1}{4}$watt
S18010	R158	18	C	10%	$\frac{1}{4}$watt
16K	C1	.1uf	POL	10%	400v
16J	C2	6-30pf	Cer. Trimmer		
16J	C3	6-30pf	Cer. Trimmer		
16J	C4	6-30pf	Cer. Trimmer		
16J	C5	6-30pf	Cer. Trimmer		
59K	C6	100pf	SM	10%	
61K	C7	1,000pf	SM	10%	
16J	C8	6-30pf	Cer. Trimmer		
16J	C9	6-30pf	Cer. Trimmer		
63X	C10	15pf	SM	5%	
64X	C11	20pf	SM	5%	
16J	C12	6-30pf	Cer. Trimmer		
16J	C13	6-30pf	Cer. Trimmer		
65X	C14	30pf	SM	5%	
63X	C15	15pf	SM	5%	
25K	C16	.01uf	POL	10%	400v

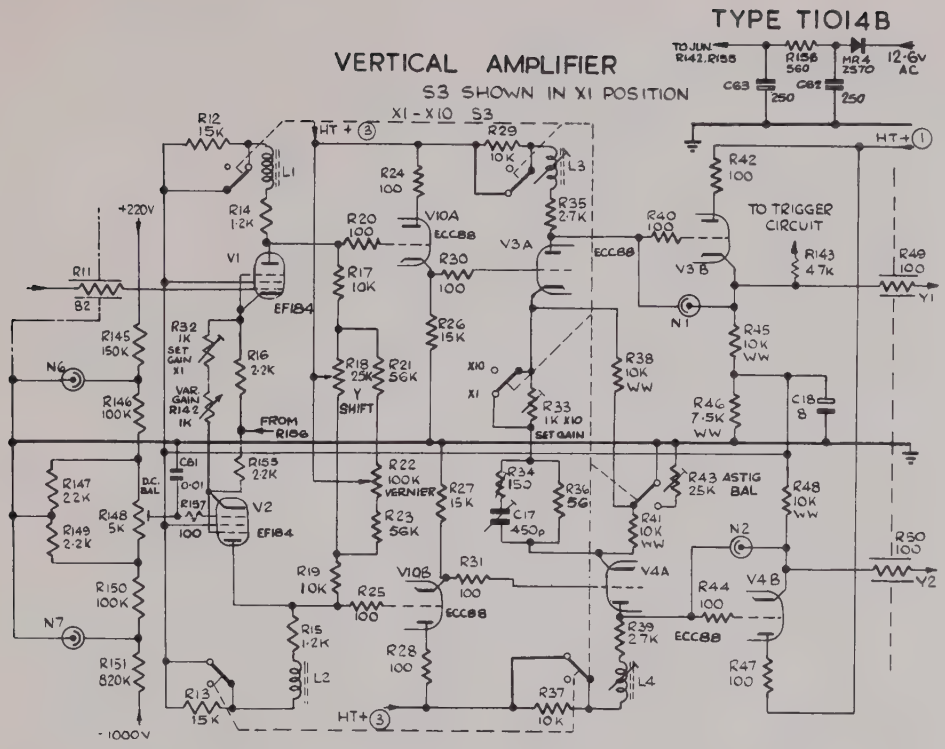
INPUT ATTENUATOR



VERTICAL AMPLIFIER

TELEQUIPMENT Part No.	Circuit Ref.	Value	Type	Tol.	Rating
S15310	R12	15K	C	10%	¼watt
S15310	R13	15K	C	10%	¼watt
S12210	R14	1.2K	C	10%	¼watt
S12210	R15	1.2K	C	10%	¼watt
S22210	R16	2.2K	C	10%	¼watt
S10310	R17	10K	C	10%	¼watt
6 C	RV18	25K	CP "Y SHIFT"		
S10310	R19	10K	C	10%	¼watt
S10110	R20	100	C	10%	¼watt
S56310	R21	56K	C	10%	¼watt
6 C	RV22	100K	CP "Y SHIFT VERNIER"		
S56310	R23	56K	C	10%	¼watt
S10110	R24	100	C	10%	¼watt
S10110	R25	100	C	10%	¼watt
Y15310	R26	15K	C	10%	1watt
Y15310	R27	15K	C	10%	1watt
S10110	R28	100	C	10%	¼watt
Y10310	R29	10K	C	10%	1watt
S10110	R30	100	C	10%	¼watt
S10110	R31	100	C	10%	¼watt

(continued)



TELEQUIP-
MENT
Part No.

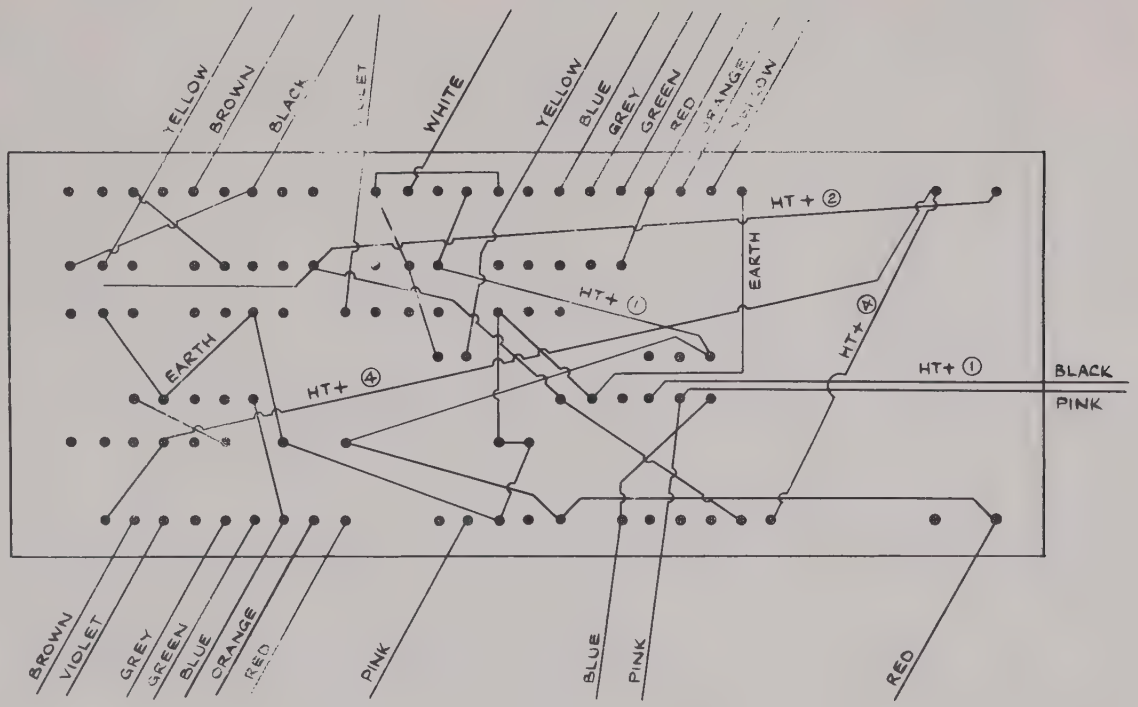
Circuit Ref.	Value	Type	Tolerance	Rating
R142	1K	C Potentiometer 'VAR GAIN'		
R145	150K	C	10%	$\frac{1}{4}$w
R146	100K	C	10%	$\frac{1}{4}$w
R147	2.2K	C	10%	$\frac{1}{4}$w
R148	5K	C Potentiometer		
R149	2.2K	C	10%	$\frac{1}{4}$w
R150	100K	C	10%	$\frac{1}{4}$w
R151	820K	C	10%	$\frac{1}{2}$w
R155	2.2K	C	10%	$\frac{1}{4}$w
R156	560	C	10%	$\frac{1}{4}$w
R157	100	C	10%	$\frac{1}{4}$w
C61	0.01	MP Capacitor		
N6		3L Neon 60v		
N7		3L Neon 60v		

VERTICAL AMPLIFIER (continued)

TELEQUIPMENT Part No.	Circuit Ref.	Value	Type	Tol.	Rating
37C	RV32	1K	Carbon Pot. (SET Y GAIN X 1)		
37C	RV33	1K	Carbon Pot. (SET Y GAIN X 10)		
11C	RV34	150	Carbon Pot.		
Y27210	R35	2.7K	C	10%	1watt
S56010	R36	56	C	10%	$\frac{1}{4}$watt
Y10310	R37	10K	C	10%	1watt
37M	R38	10K	WW	10%	3watt
Y27210	R39	2.7K	C	10%	1watt
S10110	R40	100	C	10%	$\frac{1}{4}$watt
37M	R41	10K	WW	10%	3watt
S10110	R42	100	C	10%	$\frac{1}{4}$watt
19C	RV43	25K	Carbon Potentiometer Astig. Bal.		
S10110	R44	100	C	10%	$\frac{1}{4}$watt
37M	R45	10K	WW	10%	3watt
L63	R46	7.5K	WW	10%	3watt
S10110	R47	100	C	10%	$\frac{1}{4}$watt
37M	R48	10K	WW	10%	3watt
S10110	R49	100	C	10%	$\frac{1}{4}$watt
S10110	R50	100	C	10%	$\frac{1}{4}$watt
S10110	R142	100	C	10%	$\frac{1}{4}$watt
S47210	R143	4.7K	C	10%	$\frac{1}{4}$watt
S22210	R145	2.2K	C	10%	$\frac{1}{4}$watt
	R146	560	C	10%	$\frac{1}{4}$watt
15J	C17	450pf	MICA TRIMMER		
18J	C18	8	ELEC. 150v DC.		
33X	C62	250	ELEC.		18volts
33X	C63	250	ELEC.		18volts
36Y	N1	3L	NEON 60v		
36Y	N2	3L	NEON 60v		
	L1	FIXED INDUCTANCE			
	L2	FIXED INDUCTANCE			
	L3	VARIABLE INDUCTANCE			
	L4	VARIABLE INDUCTANCE			
	MR4	RECTIFIER ZS75.			

CONNECTIONS TO MAIN TAGBOARD

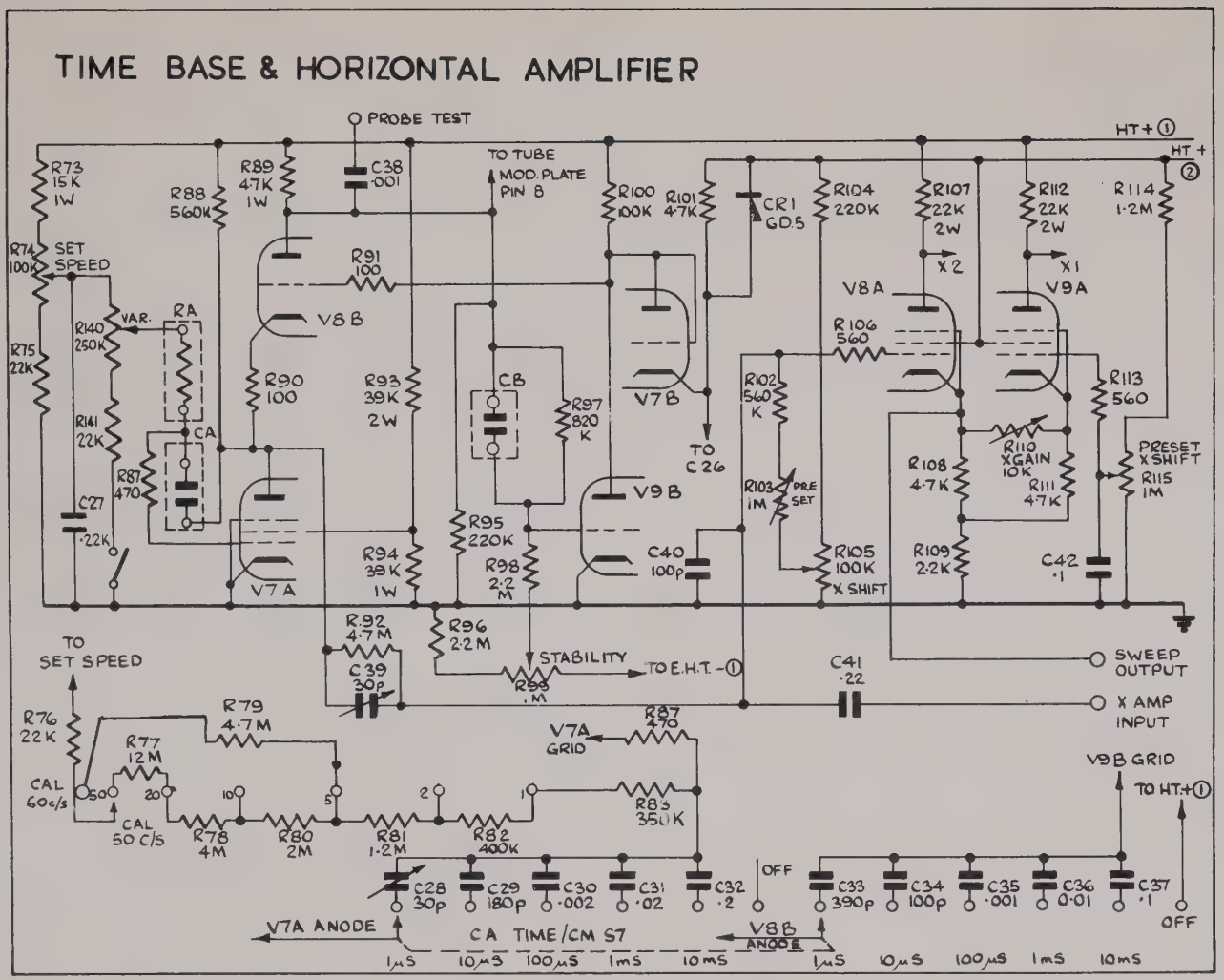
(VIEWED FROM COMPONENT SIDE)



TIME BASE & HORIZONTAL AMPLIFIER

TELEQUIPMENT Part No.	Circuit Ref.	Value	Type	Tol.	Rating
Y15310	R73	15K	C	10%	1watt
39C	R74	100K	CP "SET SPEED"		
S22310	R75	22K	C	10%	$\frac{1}{4}$watt
S22310	R76	22K	C	10%	$\frac{1}{4}$watt
4 M	R77	2x6 M	HSC	1%	$\frac{1}{4}$watt
6 M	R78	4M	HSC	1%	$\frac{1}{4}$watt
5 M	R79	4.7M	HSC	1%	$\frac{1}{4}$watt
8 M	R80	2M	HSC	1%	$\frac{1}{4}$watt
9 M	R81	1.2M	HSC	1%	$\frac{1}{4}$watt
15M	R82	400K	HSC	1%	$\frac{1}{4}$watt
16M	R83	350K	HSC	1%	$\frac{1}{4}$watt
S47110	R87	470	C	10%	$\frac{1}{4}$watt
Y47210	R89	4.7K	C	10%	1watt
S10110	R90	100	C	10%	$\frac{1}{4}$watt
S10110	R91	100	C	10%	$\frac{1}{4}$watt
S47510	R92	4.7M	C	10%	$\frac{1}{4}$watt
039310	R93	39K	C	10%	2watt
039310	R94	39K	C	10%	2watt
37P	R140	250K	CP 'VARIABLE SPEED'		
S22310	R141	22K	C	10%	$\frac{1}{4}$watt

(continued)


TIME BASE & HORIZONTAL AMPLIFIER
PROBE TEST
HT+ ①
HT+ ②
TO TUBE MOD. PLATE PIN 8
R73 15K 1W
R74 100K SET SPEED
R75 22K
R88 560K
R89 4·7K 1W
C38 ·001
R91 100
V8B
R90 100
R93 39K 2W
CB
R97 820K
V7B
R100 100K
R101 4·7K
CR1 GD5
R104 220K
R107 22K 2W
X2
R112 22K 2W
X1
R114 1·2M
V8A
V9A
R106 560
R140 250K VAR.
RA
R141 22K
CA
R87 470
C27 ·22K
V7A
R94 39K 1W
R95 220K
R98 2·2M
V9B
C40 100p
TO C26
R102 560K
R103 1M PRE SET
R105 100K X SHIFT
R108 4·7K
R110 XGAIN 10K
R111 4·7K
R109 2·2K
R113 560
PRESET X SHIFT R115 1M
C42 ·1
R92 4·7M
C39 30p
R96 2·2M
STABILITY R99 ·M
TO E.H.T. -①
C41 ·22
SWEEP OUTPUT
X AMP INPUT
TO SET SPEED
R76 22K
R79 4·7M
R77 12M
CAL 60c/s
CAL 50 C/S
R78 4M
R80 2M
R81 1·2M
R82 400K
R87 470
V7A GRID
R83 350K
V9B GRID
TO HT.+①
C28 30p
C29 180p
C30 ·002
C31 ·02
C32 ·2
OFF
C33 390p
C34 100p
C35 ·001
C36 0·01
C37 ·1
OFF
V7A ANODE
CA TIME/CM S7
V8B ANODE
1μS 10μS 100μS 1mS 10mS 1μS 10μS 100μS 1mS 10mS

TIME BASE & HORIZONTAL AMPLIFIER (continued)

TELEQUIPMENT Part No.	Circuit Ref.	Value	Type	Tol.	Rating
S22410	R95	220K	C	10%	¼watt
S22510	R96	2.2M	C	10%	¼watt
S82510	R97	820K	C	10%	¼watt
S22510	R98	2.2M	C	10%	¼watt
47C	R99	1M	CP "STABILITY"		
010410	R100	100K	C	10%	2watt
S47210	R101	4.7K	C	10%	¼watt
S56410	R102	560K	C	10%	¼watt
35C	R103	1M	PS "SET TRACE LENGTH" (100 us)		
S22410	R104	220K	C	10%	¼watt
42C	R105	100K	CP "X SHIFT"		
S56110	R106	560	C	10%	¼watt
022310	R107	22K	C	10%	2watt
S47210	R108	4.7K	C	10%	¼watt
S22210	R109	2.2K	C	10%	¼watt
42C	R110	10K	CP "X GAIN"		
S47210	R111	4.7K	C	10%	¼watt
022310	R112	22K	C	10%	2watt
S56110	R113	560	C	10%	¼watt
S12510	R114	1.2M	C	10%	¼watt
35C	R115	1M	PS 'SET X SHIFT'		

(continued)

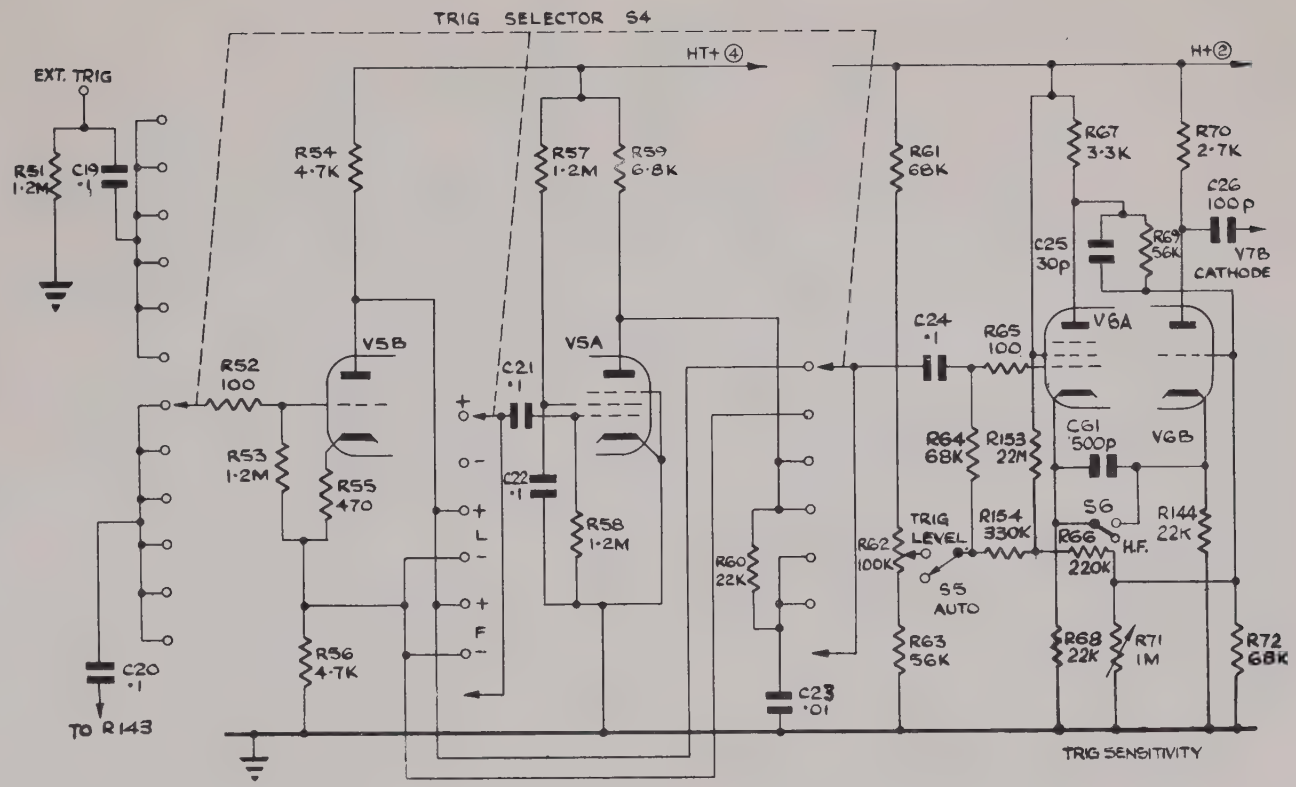
TIME BASE & HORIZONTAL AMPLIFIER (continued)

TELEQUIPMENT Part No.	Circuit Ref.	Value	Type	Tol.	Rating
10J	C27	.22uf	POL	10%	400V
14J	C28	3-30pf	AIR TRIMMER		
9K	C29	180pf	SM	5%	
36K	C30	.002uf	POLY	2%	
37K	C31	.02uf	POLY	2%	
27K	C32	2 x .1uf	MP	5%	500V
42K	C33	39pf	CER	10%	
53K	C34	100pf	CER	10%	
18K	C35	.001uf	MP	10%	500V
25K	C36	.01uf	MP	10%	500V
26K	C37	.1uf	MP	10%	500V
18K	C38	.001uf	MP	10%	500V
16J	C39	6-30pf	CER TRIMMER SET TRACE LENGTH (1 us)		
53K	C40	100pf	CER	10%	
10J	C41	.22uf	POL	10%	400V
16K	C42	.1uf	POL	10%	400V
34E	CR1	OA81	GERMANIUM DIODE		

TRIGGER CIRCUIT & SYNC. SEPARATOR

TELEQUIPMENT Part No.	Circuit Ref.	Value	Type	Tol.	Rating
S12510	R51	1.2M	C	10%	$\frac{1}{4}$watt
S10110	R52	100	C	10%	$\frac{1}{4}$watt
S12510	R53	1.2M	C	10%	$\frac{1}{4}$watt
S47210	R54	4.7K	C	10%	$\frac{1}{4}$watt
S47110	R55	470	C	10%	$\frac{1}{4}$watt
S47210	R56	4.7K	C	10%	$\frac{1}{4}$watt
S12510	R57	1.2M	C	10%	$\frac{1}{4}$watt
S12510	R58	1.2M	C	10%	$\frac{1}{4}$watt
S68210	R59	6.8K	C	10%	$\frac{1}{4}$watt
S22310	R60	22K	C	10%	$\frac{1}{4}$watt
S68310	R61	68K	C	10%	$\frac{1}{4}$watt
47C	RV62	100K	CP 'TRIG.LEVEL'		
S56310	R63	56K	C	10%	$\frac{1}{4}$watt
S56310	R64	56K	C	10%	$\frac{1}{4}$watt
S10110	R65	100	C	10%	$\frac{1}{4}$watt
S22410	R66	220K	C	10%	$\frac{1}{4}$watt
S33210	R67	3.3K	C	10%	$\frac{1}{4}$watt
Y22310	R68	22K	C	10%	1watt
S56310	R69	56K	C	10%	$\frac{1}{4}$watt
S27210	R70	2.7K	C	10%	$\frac{1}{4}$watt
S10510	R71	1M	CP PRESET 'TRIG.SENSITIVITY'		
S68310	R72	68K	C	10%	$\frac{1}{4}$watt
Y22310	R144	22K	C	10%	1watt
922610	R153	22M	C	10%	$\frac{1}{4}$watt
S33410	R154	330K	C	10%	$\frac{1}{4}$watt
16K	C19	.1uf	POL	10%	400 V
16K	C20	.1uf	POL	10%	400 V
16K	C21	.1uf	POL	10%	400 V
16K	C22	.1uf	POL	10%	400 V
25K	C23	.01uf	MP	10%	500 V
16K	C24	.1uf	POL	10%	400 V
41K	C25	30pf	CER	10%	
53K	C26	100pf	CER	10%	
31K	C61	500pf	CER	10%	150 V

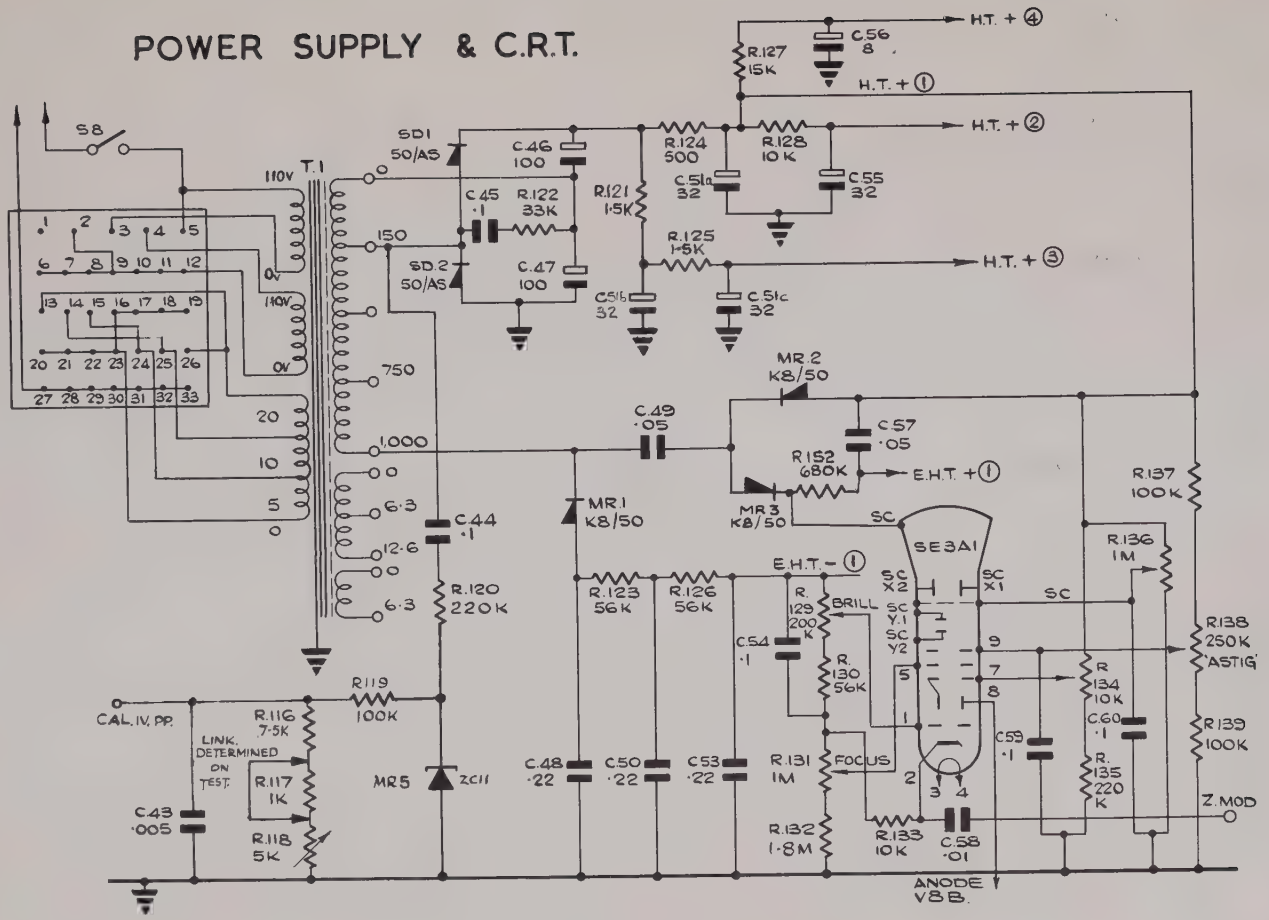
TRIG. CIRCUIT & SYNC. SEPARATOR



POWER SUPPLY, C.R.T. AND VOLTAGE CALIBRATOR

TELEQUIPMENT Part No.	Circuit Ref.	Value	Type	Tol.	Rating
105L	R116	7.5K	HSC	1%	¼watt
S10210	R117	1K	C	10%	¼watt
31C	R118	5K	PS 'SET 1 VOLT P.P. CAL'		
69L	R119	100K		5%	¼watt
S22410	R120	220K	C	10%	¼watt
124L	R121	1.5K	M.O.	5%	3.25watt
S33310	R122	33K	C	10%	¼watt
S56310	R123	56K	C	10%	¼watt
30M	R124	500	WW	10%	3watt
124L	R125	1.5K	M.O.	5%	3.25watt
S56310	R126	56K	C	10%	¼watt
44M	R127	15K	WW	10%	3watt
37M	R128	10K	WW	10%	3watt
48C	R129	200K	CP "BRILLIANCE"		
S56310	R130	56K	C	10%	¼watt
48C	R131	1M	CP 'FOCUS'		
918510	R132	1.8M	C	10%	¼watt
S10310	R133	10K	C	10%	¼watt
33C	R134	10K	PS 'SET MOD. PLATE BIAS'		
S22410	R135	220K	C	10%	¼watt
35C	R136	1M	PS 'SET I.P.S. VOLTAGE'		
S10410	R137	100K	C	10%	¼watt
27C	R138	250K	CP "ASTIG"		
S10410	R139	100K	C	10%	¼watt
S68410	R152	680K	C	10%	¼watt

(continued)


POWER SUPPLY & C.R.T.
S8
T.1
110v
0v
SD1 50/AS
SD2 50/AS
C.46 100
C.45 ·1
R.122 33K
C.47 100
R.121 1·5K
R.124 500
R.128 10K
R.127 15K
C.56 8
C.55 32
C.51a 32
C.51b 32
C.51c 32
R.125 1·5K
H.T. + ④
H.T. + ①
H.T. + ②
H.T. + ③
150
750
1,000
20
10
5
0
6·3
12·6
6·3
C.44 ·1
R.120 220K
MR.2 K8/50
MR.1 K8/50
MR.3 K8/50
C.49 ·05
C.57 ·05
R.152 680K
E.H.T. + ①
E.H.T. - ①
SE3A1
SC
SC X2
SC X1
SC Y.1
SC Y2
BRILL
FOCUS
R. 129 200K
R. 130 56K
R. 131 1M
R. 132 1·8M
R. 133 10K
C.58 ·01
C.59 ·1
C.60 ·1
R. 134 10K
R. 135 220K
R.136 1M
R.137 100K
R.138 250K 'ASTIG'
R.139 100K
Z. MOD
ANODE V8B.
R.123 56K
R.126 56K
C.54 ·1
C.48 ·22
C.50 ·22
C.53 ·22
R.119 100K
CAL. IV. PP.
R.116 7·5K
LINK, DETERMINED ON TEST.
R.117 1K
R.118 5K
C.43 ·005
MR5 ZC11

POWER SUPPLY, C.R.T. AND VOLTAGE CALIBRATOR

(continued)

TELEQUIPMENT Part No.	Circuit Ref.	Value	Type	Tol.	Rating
20K	C43	.005uf	MP	10%	500V
16K	C44	.1uf	POL	10%	400V
16K	C45	.1uf	POL	10%	400V
60J	C46	100uf	ELEC		275V
60J	C47	100uf	ELEC		275V
49X	C48	.22uf	P		1,200V
39J	C49	.05uf	P	10%	2,000V
49X	C50	.22uf	P		1,200V
68J	C51a, b & c	32+32+32uf	ELEC		450V
49X	C53	.22uf	P		1,200V
16K	C54	.1uf	POL		400V
2J	C55	32uf	ELEC		450V
2J	C56	8uf	ELEC		450V
13K	C57	.05uf	P	10%	2,600V
25K	C58	.01uf	MP		1,500V
16K	C59	.1uf	POL	10%	400V
16K	C60	.1uf	POL	10%	400V

(continued)

POWER SUPPLY, C.R.T. AND VOLTAGE CALIBRATOR

(continued)

TELEQUIPMENT Part No.	Circuit Ref.		
180	SD1	50 AS	SILICON RECTIFIER
180	SD2	50 AS	SILICON RECTIFIER
60	MR1	K8/50	SELENIUM RECTIFIER
60	MR2	K8/50	SELENIUM RECTIFIER
60	MR3	K8/50	SELENIUM RECTIFIER
68T	MR5	ZC11	ZENER DIODE

53S — POWER TRANSFORMER

PRIMARY	SECONDARY		
0 - 110	150V	120ma	DC
0 - 110	350V	1ma	RMS
	750V	1ma	RMS
0 - 5 - 10 - 20	1000V	1ma	RMS
	6.3V	2.5amps	RMS
	12.5V	1 amp	RMS
	6.3V	.6 amp	RMS

TUBES & C. R. T.

V1	EF184	(6 EJ 7)	Mullard
V2	EF184	(6 EJ 7)	Mullard
V3	ECC88	(6 DJ 8)	Mullard
V4	ECC88	(6 DJ 8)	Mullard
V5	ECF80	(6 BL8)	Brimar or Mullard or Mazda
V6	ECF80	(6 BL8)	Brimar or Mullard or Mazda
V7	ECF80	(6 BL8)	Brimar or Mullard or Mazda
V8	ECF80	(6 BL8)	Brimar or Mullard or Mazda
V9	ECF80	(6 BL8)	Brimar or Mullard or Mazda
V10	ECC88	(6 DJ 8)	Brimar or Mullard
C.R.T.	SE3A1		Sylvania Thorn

BASE PIN CONNECTIONS

ECF80	ECC88	SE3A1	EF184
1 A_T	A_1	1 G	1 K
2 G_P	G_1	2 K	2 G_1
3 G_2	K_1	3 H	3 K
4 H	H	4 H	4 H
5 H	H	5 A_2	5 H
6 Ap	A_2	6 IC	6 S
7 Kp	G_2	7 A_1	7 A
8 K_T	K_2	8 Mod. Plate	8 G_2
9 G_T	S	9 A_3	9 G_3
		10 IC	
		11 IC	
		12 IC	

VOLTAGE TABLES

All measurements made on 1,000V Range unless otherwise stated.

Measurements over 1,000V made on 2,500 volts Range.

Instrument used 'Avo' model '8' 20,000 ohms per volt.

Measurements made with the absence of any 'Y' signal and with the time base set to 1 mS/cm with the stability advanced until time base just free runs. All voltages are measured with respect to chassis.

VOLTAGE TABLES

	Plate V	Screen grid-(G2) V	Control grid-(G1) V	Cathode V
V1	90	92	0	1.5*
V10A	225	-	90	97
V2	90	92	0	1.5*
V10B	225	-	90	97
V4A	207	227	97	100
V4B	350	-	207	210
V5A	207	227	97	100
V5B	350	-	207	210
V5A	193	30	0.5	0
V5B	155	-	37	50
V6A	197	210	80	87
V6B	185	-	80	87
V7A	170	130	0	0
V7B	125	-	125	205
V8A	215	210	52	60
V8B	300	-	150	180
V9A	265	210	48	52
V9B	92	-	-15	0

* Voltmeter on 10V Range

CATHODE RAY TUBE	
A4	2.9KV
A3	190V
A2	-800V
A1	340V
Grid	-1000V
Cathode	-925V

B+ RAIL VOLTAGES	
HT+1	355V
HT+2	210V
HT+3	230V
HT+4	200V
EHT+1	2.9KV
EHT-1	1050 V

TELEQUIPMENT LIMITED

313 Chase Road, Southgate, London, N.14.

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